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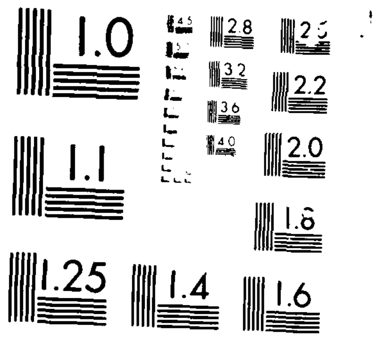
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CENTRAL DENTAL HIGH-VOLUME ORAL EVACUATION (HVE) SYSTEMS

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May 1986

Interim Report for Period January 1985 - December 1985

Approved for public release; distribution is unlimited.

USAF SCHOOL OF AEROSPACE MEDICINE
Aerospace Medical Division (AFSC)
Brooks Air Force Base, TX 78235-5301

NOTICES

This interim report was submitted by personnel of the Dental Investigation Service, Clinical Sciences Division, USAF School of Aerospace Medicine, Aerospace Medical Division, AFSC, Brooks Air Force Base, Texas, under job order DSB38900.

This report has been reviewed and is approved for publication.

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

This report includes the minimum requirements for central dental high-volume oral evacuation (HVE) systems and associated centrally plumbed distribution networks for use in USAF dental health facilities. These specifications are interim until joint evaluations by the Dental Investigation Service and the Occupational and Environmental Health Laboratory establish standards for dental clinics.

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83 APR edition may be used until exhausted
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CONTENTS

CENTRAL DENTAL HIGH-VOLUME ORAL EVACUATION (HVE) SYSTEMS

1. INTRODUCTION

1.1 Dental High-volume Oral Evacuation System. The dental high-volume oral evacuation (HVE) system is an independent clinical vacuum system specifically designed for scavenging, collection, and disposal of liquids, solids, and aerosols from the patient's mouth. Control of aerosols generated by the high-speed air turbine handpiece and emanating from the operating site is essential to prevent contamination of breathing zones and the treatment environment in general. Equally important for safe and effective treatment delivery is the ability of the HVE to maintain a clear visual pathway and operating site during operating procedures.

1.2 Application. The HVE system described and specified herein applies to composite or free-standing USAF dental facilities containing more than six dental treatment rooms (DTRs).

1.3 Components. The HVE system consists primarily of the following components:

- Two remote-controlled and monitored vacuum turbines (turboexhausters) with individual noise, flow, and vacuum controls.

- One or two central separator/collector tank(s) equipped with overflow protectors, flow and drain controls, self-cleaning capability, and a connection to sewer.

1.4 Delivery. HVE service is distributed to designated utility centers in all DTRs in the dental facility by a specially sized and equipped centrally piped distribution network for wet line operation.

1.5 Performance. The system and the distribution network are designed so that all inlets function in a specified, consistent performance range.

1.6 End Items. Clinical end items (suction tips, hand valves, hoses, and solids collectors) are considered part of the DTR delivery system, and are not included in this report.

1.7 Guidelines. The guidelines provided in this document are minimum requirements for safe, proficient, reliable, and cost-effective HVE systems. The information provided is applicable to all HVE systems in new construction and in system replacement projects. The information is intended to supplement and provide a basis for other design criteria, guide specifications, codes and specifically Air Force Regulation 88-50, "Criteria for Design and Construction of Air Force Health Facilities."

1.8 System and Distribution Network. The HVE system and associated distribution network are not used in flammable gas locations, are not used to scavenge flammable anesthetic gas, and are not installed in inpatient

treatment areas. Therefore, the system and distribution network are not within the jurisdiction of National Fire Protection Association (NFPA) Standard 99.

2. DEFINITIONS

2.1 Air Flow. Air-flow references are in standard cubic feet per minute (SCFM).

2.2 Antisurge Valve. A mechanically controlled in-line air bleed valve designed to sense and compensate for change in system vacuum pressure.

2.3 Backward Curve Impellers. Turboexhauster impellers whose vanes are arched across the impeller radius so that the convex curve faces the direction of rotation to enhance turboexhauster efficiency and performance.

2.4 Central Separator/Collector Tank. A negative pressure vessel designed for cyclonic separation of air from liquid and solid HVE effluent, designed, sized, and equipped as specified.

2.5 Directional Flow Valve. An in-line swinging gate valve used for unidirectional flow control.

2.6 Centrally Piped Distribution Network. The central plumbing for distribution of HVE service throughout the dental facility, designed, sized, and equipped as specified; beginning with the riser input terminal fittings in specified locations; and terminating at the point of connection to the HVE system central separator/collector tank(s).

2.7 High-volume Oral Evacuation System. The assembly of components for the specified production of clinical dental oral vacuum service and for effluent disposal; consisting of two multistage vacuum turbines, central separator/collector tank(s), and all electrical, mechanical, fluidic and noise controls, components and interconnections specified and/or required; designed and sized as specified for continuous duty; and terminating at the point of connection to the HVE centrally piped distribution network.

2.8 Input Terminal. Specified riser end fittings.

2.9 Internal Washdown System. An automatic, serviceable, cold water rinsing system with spray head located in the top of the HVE separator/collector tank(s) for timed washdown of the interior of the tank(s) to enhance sanitation and prevent sludge buildup.

2.10 Isolation Pads. Blocks or pads of resilient material used to support equipment frames or bases to prevent transmission of equipment vibration to the structural parts of the facility.

2.11 Liquid Level Sensor. (Primary tank overflow guard) A system of electrodes (detectors) installed in the HVE separator/collector tank(s) at locations to detect the effluent levels within the tank(s) at high and low

points. When immersed in effluent, the electrode conducts an electrical current to operate a relay device which either starts a pump or actuates a solenoid valve to effect tank drainage.

2.12 Manifold. The downstream end of the HVE centrally piped distribution network consisting of a nominally sized pipe which connects the trunk lines to the system separator/collector tank(s).

2.13 Pipe Isolators. Flexible, resilient, band-clamped sleeves used for plumbed connections to equipment to prevent transmission of equipment vibration to connected pipes and components.

2.14 Riser. The upstream end of the HVE centrally piped distribution network consisting of a 3/4-in. nominally sized pipe which connects the riser input terminal fitting to the HVE trunk line.

2.15 Safety Float. (Secondary tank overflow guard) A caged float valve located in the HVE separator/collector tank such that a high liquid (effluent) level caused the float to close the tank exhaust air output to prevent further effluent input and subsequent turboexhauster damage.

2.16 Silencer. An in-line device to provide abatement of air-generated noise without line restriction and back pressure.

2.17 Solenoid Valve. An electrically operated in-line valve.

2.18 Trunk Lines. The nominal pipe size branch lines of the HVE centrally piped distribution network which connect the risers to the manifold.

2.19 Turboexhauster. A multistage, direct drive, vacuum-producing turbine designed, sized, and equipped as specified, used to power the HVE system.

2.20 Vacuum Pressure. Vacuum pressure references are in inches of mercury (in. Hg).

2.21 Volume Control Valve. An adjustable, in-line, minimum restriction valve for air flow control.

2.22 Wet-Line Operation. Piped transport of a combination of air, liquids, and solids.

3. REQUIREMENTS

3.1 Equipment Design. The HVE system and HVE central distribution network are designed to support the requirements for general dental oral evacuation and, except for the use of HVE vacuum producers to power the central janitorial vacuum system as specified elsewhere, shall not be used for any other purpose.

3.2 System Devices. The HVE system and central distribution network shall consist of standard manufactured products, complete with all devices

normally furnished and devices required herein. When devices normally furnished conflict with devices required herein, the devices required herein shall have precedence. The HVE system shall be supplied by a manufacturer regularly engaged in the manufacture of commercially available, industrial-quality central vacuum systems for at least two years prior to bid opening. The manufacturer shall supply a complete system assembly and shall serve as a single source for spare parts and service for all components in the system regardless of original vendor.

3.3 Installation. The HVE system shall be installed in a well-ventilated mechanical space within the served facility or in a separate mechanical space structure within 20 ft of the served facility.

3.4 Location. The HVE system shall have access to sewer for effluent disposal. New construction projects shall provide a dedicated floor sink (12x12x6 in. deep) with 3-in. drain immediately adjacent to the system separator/collector tank(s) for gravity drainage.

3.5 Performance. Individual DTR HVE performance, measured with one inlet operating in not less than 70% of the total facility DTRs simultaneously, shall be within the following ranges:

Volume: 12-15 standard cubic feet per minute (SCFM)

Vacuum: 7-8 inches of mercury (in. Hg)

3.6 Performance Measure. Performance shall be measured by the specified test procedures.

3.7 HVE System.

3.7.1 The HVE system shall include, but not be limited to, the following major components:

- Central separator/collector tank(s)
- Mechanical and electrical tank overflow protectors
- Internal tank washdown system
- Air control solenoid valves or high pressure in-line waste pumps
- Turboexhausters
- Silencers
- Volume control valves
- Antisurge valves
- Directional flow valves
- Isolation pads

- Plumbing isolators
- Electrical controls and enclosures
- Remote control panel

3.7.2 Separator/collector tank(s).

3.7.2.1 The HVE system shall contain one or two separator/collector tank(s) of specified capacity according to facility size (number of DTRs) as follows:

No. of DTRs	Separator Tanks Quantity	Separator Tanks Size (gal)
1-6	1	20
7-10	1	40
11-20	1	80
21-30	2	40
31 and above	2	80

3.7.2.2 Tank(s) shall be high negative pressure vessels certified by the system supplier to withstand a constant negative pressure of not less than 20 in. Hg. Tanks shall be constructed of nonmetallic, inert, reinforced plastic or hot-dipped galvanized steel. Tank bottoms shall be convex with a drain connection located at the apex of convexity to enhance discharge of all contents. Tank inlets shall be tangential to the tank body to effect cyclonic separation of air from effluent.

3.7.2.3 Tank(s) shall be equipped with a timer-controlled, internal, cold water washdown system, adjustable for frequency and duration of washdown. The system shall include a cold water supply filter with 40-mesh stainless steel screens (located to protect the solenoid valve), a water supply solenoid valve, a 360° spray nozzle, and a 115-VAC clock control mechanism. The clock shall control the solenoid to effect frequency (once each 24-h interval) and duration (not more than 3 min) of washdown. The clock shall have skip-interval capability to eliminate washdown during weekends.

3.7.2.4 Each tank shall be equipped with a primary overflow protection system consisting of electronic high- and low-liquid-level sensors, power supply, and a 115-VAC electrically operated tank output air-solenoid valve. The solenoid valve shall be located to control the output air from tank to turboexhauster and shall be switched by the sensors. In multiple-tank installations, one tank shall be adjusted to sense 90% of its capacity, and the other tank 100% of its capacity by the liquid-level sensing devices. This procedure shall allow for nonsimultaneous discharging and, therefore, uninterrupted HVE function to the facility.

3.7.2.5 Each tank shall be equipped with a secondary overflow protection device consisting of a caged, mechanical safety float positioned to close the tank output air orifice in the event of high-liquid-level sensor failure.

3.7.2.6 Each tank shall be equipped with a gate- or swing-type directional flow valve at the bottom drain. With negative pressure in the tank (systems operating), the check valve shall remain closed to maintain vacuum. When negative pressure ceases, either by exhauster shutdown or closure of the outgoing air-solenoid control by the liquid-level sensor, the check valve shall open and the tank shall undergo gravity drainage to sewer.

3.7.2.7 In any HVE installation, where a floor sink cannot be made available for separator tank drainage, and effluent must be moved overhead to sewage input, high-pressure pumps shall be the option of choice. One pump per separator tank shall be installed. Pumps shall be high-pressure in-line types connected between the separator tank drain outlet and the sewer inlet. The gate- or swing-type valve normally installed at the tank drain outlet shall be relocated downstream of the pump output side to assure pump priming and preclude pump impeller damage from dry initial startup. Pumps shall be capable of sufficient power as to accomplish draining of the separator tank against vacuum produced by the turbine. When high-pressure pumps are used, the output air-solenoid valve between the separator tank air outlet and the turboexhauster input shall not be used. Power to the high-pressure in-line pumps shall be controlled by the liquid level sensors in the separator tanks.

3.7.2.8 All interconnecting piping between multiple tanks and between tank(s) and turboexhausters shall be acrylonitrile butyl styrene (ABS) or polyvinyl chloride (PVC), conforming to Schedule 40 or Class 200 specifications.

3.7.3 <u>Turboexhausters</u>.

3.7.3.1 The HVE system shall contain two turboexhausters connected in parallel.

3.7.3.2 Each turboexhauster shall have a minimum capability to produce the specified individual DTR HVE performance in 70% of the total number of facility DTRs, to include the DTRs most distant from the vacuum source.

3.7.3.3 Line losses caused by the HVE centrally piped distribution network shall be compensated by adjustment of turboexhauster capability.

3.7.3.4 Power to operate the turboexhaust shall be in direct proportion to the volume of air exhausted and shall not exceed the normal motor rating.

3.7.3.5 Horsepower rating for the turboexhauster drive motor shall not exceed the following quantities for capacities and pressures shown:

VACUUM (in. Hg.)

H.P.	7	8	9	10	11	12
	SCFM					
5	90	64				
7 1/2	180	165	100			
10	240	220	185	150		
15	375	350	275	200	125	100
20	560	475	400	300	260	225
25	770	600	475	400	335	300
30	840	725	625	540	430	360
40	1225	1000	825	650	565	480
50	1530	1250	1100	900	725	600

3.7.3.6 Vacuum produced shall be substantially constant throughout the operating volume range of the turboexhauster regardless of the number of using DTRs (one inlet used per DTR) below the maximum design capacity of the turboexhauster.

3.7.3.7 The turboexhauster shall produce its certified volume and vacuum at the above-sea-level altitude of the installation site; shall be tested and measured by the manufacturer prior to delivery, and shall be performance certified (capacity and vacuum) as indicated by an equipment plate permanently attached to the turboexhauster.

3.7.3.8 Turboexhausters shall be self-governing, multistage, centrifugal type, of outboard design (bearings on both ends of the exhauster shaft). The turboexhauster shall operate at a speed not to exceed 3600 rpm and shall be connected to its driving motor by a flexible coupling (no belts, pulleys, or gears). A steel coupling guard encompassing the flexible coupling shall be installed between the motor and turboexhauster. Bearings may be sealed or the lubricate type. To reduce bearing lubricant temperature, a fan shall be connected directly to the exhauster shaft adjacent to exhauster shaft bearings to create a flow of ambient air over the bearing carrier while the unit is operating.

3.7.3.9 Turboexhauster cases and end plates (inlet and exhaust heads included) shall be constructed of either heavy-gauge sheet steel rigidly welded at all seams and sections, or of cast gray iron. Sheet steel end plates shall be either concave or convex for flex resistance. Inlet and exhaust connections shall be tangential to the exhauster case and sized to allow free air movement through the exhauster, without flow restriction.

3.7.3.10 Internal moving parts of the turboexhauster shall be constructed with not less than 0.125-in. clearance throughout to prevent damage by transient particulates. Impellers shall be constructed of built-up sheet metal, smooth on all surfaces to prevent imbalance by uneven dust deposits. Impellers shall be of the backward curved design to provide optimal performance over a wide range of volume requirements. Impellers shall be securely attached to the exhauster shaft by setscrews or clamps of

high-tensile material. Each impeller shall be individually balanced. The complete assembly, with motor, shall not exceed 1.5 mils of vibration when given a running test.

3.7.3.11 Each turboexhauster and its drive motor shall be separately mounted to a common frame of welded steel as an assembly.

3.7.3.12 The drive motor for the turboexhauster shall be a standard National Electrical Manufacturers Association (NEMA) 3500 rpm, T-frame, open drip-proof design; rated 200, 230 or 460 VAC, 60 Hz, three-phase; with seal- or lubricate-type bearings. Operational temperature rise of the motor shall not exceed 40° C (104° F). All motors shall be high efficiency types, as classified by NEMA criteria, and shall be rated for continuous duty.

3.7.3.13 The input of each turboexhauster shall have an adjustable air-volume control valve to prevent accidental motor overload and to provide a means of adjusting the upper design capacity limit. The volume-control valve shall be built in or immediately adjacent to the first or input stage of the turboexhauster, and shall be preset by the manufacturer during certification procedures. The volume-control valve shall be a butterfly-type to minimize air turbulence.

3.7.3.14 The input of each turboexhauster shall have a mechanical-type antisurge valve that shall operate proportionally and automatically throughout the exhauster's design range. This valve shall continually sense the negative pressure within the input line or exhauster and maintain the specified level of negative pressure by proportionally bleeding air into the system. The valve shall be equipped with a silencer to attenuate air noise to 85 decibel average (dBA) or less. The valve shall be installed in, on, or near the first stage of the turboexhauster or shall be mounted in conjunction with the directional flow valve.

3.7.3.15 The input of each turboexhauster shall have a directional flow valve to prevent backflow of air through the idle turbo-exhauster of the pair. Directional flow valves shall be gate or swing types for fast, positive response.

3.7.3.16 No manual valves shall be permitted in the system interconnecting air handling plumbing or in the system exhaust ducting.

3.7.3.17 Each turboexhauster/motor assembly frame shall be mounted on resilient isolator pads which shall be furnished by the system manufacturer. The pads shall not be fastened to the facility floor. Vibration transmission shall be limited to less than 5% of the lowest frequency of vibration.

3.7.3.18 Pipe isolators shall be furnished by the system manufacturer and shall be used for all plumbing and system component interconnections to the turboexhauster inlets and outlets for control of vibration transfer.

3.7.3.19 Each turboexhauster output shall be provided with an air-discharge silencer of the open bore expansion type. No interior baffling shall be permitted. The silencer shall attenuate exhaust air noise to a level below 85 dBA.

3.7.3.20 Exhaust extension to the facility exterior shall be through metal ducting with no bends or turns.

3.7.4 Electrical Controls.

3.7.4.1 The electrical system shall be installed in accordance with the latest edition of the National Electric Code and/or local regulations.

3.7.4.2 Each turboexhauster shall be equipped with individual electrical controls and enclosures, each to include a combination across-the-line magnetic starter with time-delay fused disconnects; a running hour meter; a two-button start-stop switch; and a warning light and audible alarm to indicate shutdown due to fuse failure.

3.7.4.3 Electrical controls shall include a complete low-voltage control function with labeled remote control panel for remote operation and monitoring of the turboexhausters.

3.7.4.4 The labeled low-voltage remote control panel shall be a dual design containing a separate on-off switch for manual switching of either or both turboexhauster(s); pilot lights to indicate operation; and a certified vacuum gage (graduated in. Hg) to monitor vacuum pressure in the system.

3.7.4.5 The labeled remote control panel shall be located in the administration/records/reception area of the dental clinic.

3.8 Centrally Piped Distribution Network.

3.8.1 Piping and fittings shall be acrylonitrile butyl styrene (ABS) or polyvinyl chloride (PVC), conforming to schedule 40 or class 200 specifications.

3.8.2 All fittings shall be long-radius bend types for turns and wye types for branching. For small bore piping for which long-radius bends are not available, two 45° bends shall be substituted for 90° turning.

3.8.3 All horizontally installed pipe shall slope (fall) not less than 0.120 in./ft toward the vacuum source.

3.8.4 All risers to all HVE inlet locations shall be 0.75-in. nominal pipe size. Risers shall connect to trunk lines whose nominal pipe sizes shall be determined by internal cross-sectional area required.

3.8.5 The cross-sectional area of all trunk lines shall be graduated, increasing toward the vacuum source. The cross-sectional areas at

any point along the trunk line shall equate to the sum of the riser cross-sectional areas connected prior to that point. Individual trunk lines shall terminate with connection to the manifold of the separator/collector tank(s).

3.8.6 An adjustable, mechanical, vacuum relief valve shall be installed at the upstream terminus of each trunk line so that all riser connections to the trunk line are between the vacuum relief valve and the manifold. The vacuum relief valve shall be adjusted to bleed air into the trunk line when all inputs to that trunk line are turned off. The air volume relief valve shall be equipped with a silencer to attenuate air noise to 85 dBA or less.

3.8.7 The HVE inlet locations and riser terminal configurations shall be provided as follows:

A. Dental treatment rooms:

(1) One inlet in each wall-mounted utility center and floor utility center when assistant's instrumentation is chair-mounted. The terminal configuration of the 3/4 in. riser shall be a 1.5-in. exposed length of 0.150 in. nominal copper pipe for clamp connection of clinical equipment hose.

(2) In wall-mounted utility centers which serve two adjacent DTRs, two inlets shall be provided by branching the riser into two terminal configurations as above.

B. Sterilizer rooms/alcoves and central sterilizing rooms:

(1) One inlet for each chemical sterilizer installed. Terminal configuration shall be a surface wall-mounted manual needle valve with 3/8-in. O.D. hose barb inlet.

(2) Inlet valves shall be located on wall, 4 in. above counter backsplash, at each chemical sterilizer location.

(3) One riser shall be branched to supply all inlets required for one room or alcove.

3.9 <u>System Inspection, Startup and Testing</u>.

3.9.1 The installer shall provide a factory-trained technical representative who shall inspect the system and distribution network, assist in startup and testing, and provide training to the personnel having maintenance responsibility.

3.9.2 The installer shall provide all testing materials, instruments, and equipment. Measuring instruments shall have current certification labels traceable to the National Bureau of Standards.

3.9.3 The HVE system and distribution network shall be tested for the air volume and vacuum requirements specified. Testing shall be performed

after the installation inspection; initial startup; and a 4-h run-in period on each turboexhauster, each operating with an air volume load equal to 70% of the facility DTRs (12 SCFM/DTR) operating simultaneously. During the run-in period, the system shall be checked for overheating every hour.

3.9.3.1 The HVE retest tip assemblies shall be attached to one HVE inlet terminal/DTR; in not less than 70% of the total facility DTRs. The DTRs tested shall include those most distant and those nearest the vacuum source. All other inlets shall be closed.

3.9.3.2 The HVE test tip assemblies shall be 6 ft of nominal 0.5-in. I.D. hose with a nominal 6-in. long, 0.4375-in. I.D. metal or plastic tube (facsimile HVE suction tip). Hoses and tubes shall be suitable for transport of not less than 15 SCFM of air at 8-in. Hg vacuum pressure without collapse.

3.9.3.3 One turboexhauster shall be started and run for 30 min before measurements begin. After 30 min, each attached HVE test tip assembly shall be measured and performance shall be as specified. When all HVE test tip assembly performance is as specified, the electrical current draw of the turboexhauster drive motor shall be measured. Electrical current draw shall not exceed the motor rating.

3.9.3.4 The test shall be repeated using the second turboexhauster.

3.9.4 A general operating test shall be conducted for the system and distribution network.

3.9.4.1 Both turboexhausters shall be started and allowed to operate simultaneously for 15 min before proceeding.

3.9.4.2 Fifteen minutes after startup, one DTR inlet in each DTR in the facility shall be opened. Not less than 1 gal of water shall be ingested by each open inlet to test general function.

3.9.4.3 Sufficient additional water shall be ingested to demonstrate the successful operation of the mechanical and electrical overfill protectors, the drainage system, and the internal tank(s) washdown system.

4. OUT-OF-CONUS INSTALLATIONS

For equipment intended specifically for installations outside of the continental United States (overseas bases), the vacuum-source drive-motor frequency and voltage requirements of this specification shall be changed to ensure compatibility with on-site electrical supply configurations. Such modifications shall not detract from equipment longevity or performance.

5. DOCUMENTATION

5.1 Instructions. The contractor shall supply two complete sets of the manufacturer's operating and maintenance instructions as specified in paragraph 5.2 to the local maintenance organization who shall be responsible for system maintenance. Bound set covers shall be labeled with the system name, building number, contractor's name, and contract number.

5.2 General Information.

5.2.1 The manual shall include an overall description and purpose of the system or equipment. The function and purpose of each system component shall be described. The description shall include the intended use, capabilities, and limitations of the system or equipment. If the manual covers more than one model of a system or equipment, or systems or equipment modified by field change, a description of the differences shall be provided. Quick-reference data shall be included and shall describe technical or design characteristics of the equipment. Examples of such data are:

- Descriptive (nameplate) data necessary to identify manufacturer, type, and model.

- Functional characteristics, such as: power and frequency requirement, voltage and amperage demands, outputs, and modes of operation.

- Rated outputs, such as: horsepower, cfm, and rpm.

- Special characteristics, such as: operating temperatures, pressure, heat dissipation, and humidity.

5.2.2 A warning page, consisting of the more vital warnings extracted from those shown throughout the manual, shall be assembled and placed on the inside cover or in front of the initial page(s) of the manual (See 5.2.7).

5.2.3 Operating instructions shall include routine and emergency procedures (manual and automatic) and safety precautions. Limits to be observed in the starting, operating, stopping, or shutting down of the equipment or system shall be provided. Adequate illustrative material shall be provided to identify and locate operating controls and indicating devices. The function of each operating control and indicating device shall be included. Emergency operating instructions shall include alternate procedures to be followed when normal operation is not possible because of emergency conditions, such as power or lubricating oil failure. Emergency operating instructions and procedures shall be located for quick and ready reference.

5.2.4 Preventive maintenance information shall be provided. Use of special tools, materials, and test equipment shall be specified, including model/type designation, as appropriate. The following procedures shall be stressed, if applicable:

5.2.4.1 Periodic cleaning and lubrication information, types of cleaning agents or lubricants required, recommended intervals, such as

monthly, quarterly, semiannually, or hours of operation shall be provided. Application points and capacity (required amounts) shall be identified. Pictorial format for lubrication is desirable. Cleaning and lubrication required during repair, replacement, and reassembly shall also be covered (See 5.2.6).

5.2.4.2 Inspection. Instructions for inspection of equipment for damage and wear shall be included. Tabular or chart format is preferred and shall include, where applicable, allowable service limits, wear, backlash, end play, length and depth of scoring, and balance. These instructions shall be sufficiently complete to serve as standards by which experienced technicians may determine when parts may be continued in use and when they must be replaced.

5.2.4.3 Instructions shall be included for verification of system performance. The location of test connections and the values expected at these points shall be included, preferably in illustrated format. Data shall include a list of equipment required to accomplish the verification, such as temperature, vacuum, pressure, hydraulic, or pneumatic gages.

5.2.5 Failures that might occur during operation of equipment shall be listed. Troubleshooting data and fault isolation techniques shall state: (a) the indication or symptom of trouble, (b) the instructions necessary, including test hookups, to determine the cause, (c) special tools and equipment, and (d) methods for returning the equipment to operating conditions. Information may be given in chart or tabular format with appropriate headings.

5.2.6 Instructions shall be provided for all removal, repair, adjustment, and replacement procedures. Exploded and sectional views giving details of assemblies shall be provided, as necessary, to clarify the text. For mechanical items, dimensional information with tolerances, clearances, wear limits, maximum bolt-down torques, and in-place balancing or other means of reducing noise level, if required, shall be supplied.

5.2.7 Notes, cautions, and warnings shall be used to emphasize important and critical instructions where necessary. Notes, cautions, and warnings shall immediately precede the applicable instructions, and shall be selected as follows:

NOTE: Concerns an operating procedure or condition which should be highlighted.

CAUTION: Concerns an operating procedure or practice which, if not strictly observed, could result in damage to, or destruction of equipment.

WARNING: Concerns an operating procedure or practice which, if not strictly observed, could result in injury to personnel or loss of life.

5.2.8 Manuals shall contain all illustrations necessary to locate and identify components of operational and maintenance significance. Where

necessary for clarity, illustrations shall show configuration, and the removal and disassembly of parts. The following types of diagrams shall be included: Schematic diagrams which show the arrangement of component devices or parts; wiring diagrams which show the connections of the circuit arrangement; and schematic piping diagrams which show the interconnection of components, of piping, tubing, or hose, and the direction of air flow.

5.2.9 Circuit diagrams for electronic units shall be provided to support maintenance and troubleshooting. Circuit diagrams shall cross-reference repair parts shown in test tables and parts lists. The function name of each stage or circuit, primary signal flow, test points, wave forms with pertinent characteristics, electrical characteristics of parts name of each variable control, input and output connectors/terminals, voltages, and signals shall be specified. Voltage and resistance values measured with controls set for normal operation shall be shown for significant points, such as terminal boards, and connectors. Interconnecting cable diagrams shall be furnished to show TO-FROM information, including any intermediate connections. Block diagrams shall be provided to support installation instructions, but shall not be substituted for necessary schematic diagrams.

5.2.10 Parts lists shall provide positive identification of parts necessary for support of the systems or equipment and shall include sufficient information to enable maintenance personnel to requisition replacement parts.

5.2.11 Clear and legible illustrations shall be provided to identify component parts and parts' relationships. Part numbers and names may be shown on illustrations or separately listed. When the illustrations omit the part numbers and names, both the illustrations and separate listings shall cross-reference illustrated part to listed part.

5.3 Format.

5.3.1 Wherever possible, commercial manuals will be incorporated without change in either content or format. The commercial manuals may be bound without disassembly in the facility manual or may be disassembled and applicable portions incorporated into existing manuals.

5.3.2 The manual may be divided into volumes to prevent the manual from becoming too bulky.

5.3.3 The text shall be specific, concise, and clearly worded to be easily understood by personnel involved in the operation, maintenance, and repair of the equipment.

5.3.4 The manual shall be oriented toward operation, maintenance, and repair of the equipment by the operators and maintenance personnel without the assistance of a manufacturer's representative.

5.4 Manuscript Review. Draft manuscript copies, in the format and number as specified, shall be provided to the Government for review (See 5.). Operating and maintenance procedures, including checkout, calibration,

alignment, scheduled removal and replacement instructions, and associated checklists shall be validated against the system (or equipment) in the presence of Government personnel.

5.5 Posted Instructions. Besides the operation and maintenance manuals, the following diagrams and instructions shall be furnished and installed, framed under glass or approved plastic laminate, and permanently posted within view of the installed system:

- Complete layout diagram to include all wiring controls, system components, plumbing, valves, and regulators.
- Selective starting and stopping procedures.
- Checking procedure for normal operation.
- Abbreviated recommended preventive maintenance procedures.
- Emergency instructions.
- Warnings and precautions.

5.6 Field Instructions. After installation, startup, testing, and acceptance of the system, the contractor shall be required to supply the services of a competent representative for not less than 4 h to instruct local maintenance and operating personnel in the proper operation and maintenance of the complete system.

6. CONCLUSIONS.

This report includes the minimum requirements for central dental high-volume oral evacuation (HVE) systems and associated centrally plumbed distribution networks for use in USAF dental health facilities. These specifications are interim until joint evaluations by the Dental Investigation Service and the Occupational and Environmental Health Laboratory establish standards for dental clinics. Any questions should be directed to USAFSAM/NGD, Brooks AFB TX 78235-5301, AUTOVON 240-3502, Commercial (512) 536-3502.

END

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